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Source: *Economic Geography,* Vol. 50, No. 2 (Apr., 1974), pp. 141-143
Published by: Taylor & Francis, Ltd.
Stable URL: https://www.jstor.org/stable/142961
Accessed: 27-10-2022 20:37 UTC

A SPACE COST CURVE OF INDUSTRIAL LOCATION

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Itabirito, 60 km from the metropolitan area of Belo Horizonte (State of Minas Gerais), is a small town of 22,000 people (1970). It was founded by the first Brazilian explorers who came from Rio de Janeiro and São Paulo at the time of the great period of gold mining in the eighteenth century. Like many other towns which had appeared due to gold mining, Itabirito started to decay when its mines became exhausted. Those who remained at Itabirito devoted themselves mainly to subsistence agriculture. The town stagnated for several years until the Brazilian government's railway reached it in 1887. Before the end of the century a steel mill and a textile factory started operations at Itabirito.

This paper uses Smith's concepts of the space cost curve and space revenue curve [4] to study the steel mill location at Itabirito. To determine the space cost curve for the firm, we had to compute the costs of producing a ton of steel at all possible locational sites along the railway joining Rio de Janeiro (the principal market and center of the output distribution) to the region of Itabirito, where the raw materials could be found more abundantly. We computed not only the cost of the required quantity of each input at its cheapest point, but also the increase in costs resulting mainly from the transportation of these inputs. We found all the primary data needed to elaborate our study in a text concerning the situation of the Brazilian mining activities and steel production,

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written in the beginning of this century [2; 3].

For all the inputs, we assumed that transportation costs varied proportionately with distance using, however, different tariffs for each type of input. Table 1 summarizes all the information needed to plot the space cost curve (*SCC*) appearing in Figure 1.

TABLE 1

STATISTICAL INFORMATION FOR THE SPACE COST CURVE OF THE STEEL MILL AT ITABIRITO, 1905

input required per ton of steel	site of basic costs	basic cost of required quantity	cost increase per km
labor services	ubiquitous	3$200	nil
capital services	ubiquitous	9$550	nil
charcoal (1 ton) SCCA	Itabirito Zone (*IT*) (125 km of forests)	43$200	0$059
iron-ore (1.45 ton) SCCB	Miguel Burnier (*MB*)	4$901	0$085
calcium, sand, and clay SCCC	Miguel Burnier (*MB*)	1$293	0$008

In addition to the information given in Table 1, we had to use the following data to construct the space cost curve: 1) the export duty that the firm would have to pay (0$300 per ton of steel) if it was located at any site within the state of Minas Gerais; and 2) the distribution costs of the final output.

To build the cost curve of distribution (*CD*) we applied a schedule used in the location studies involving the drawing of isotims and isodapanes [1]. We knew that 94 percent of the market for the products of the steel mill was concentrated in Rio, or was distributed from that region, and the other 6 percent of the market was in the region around
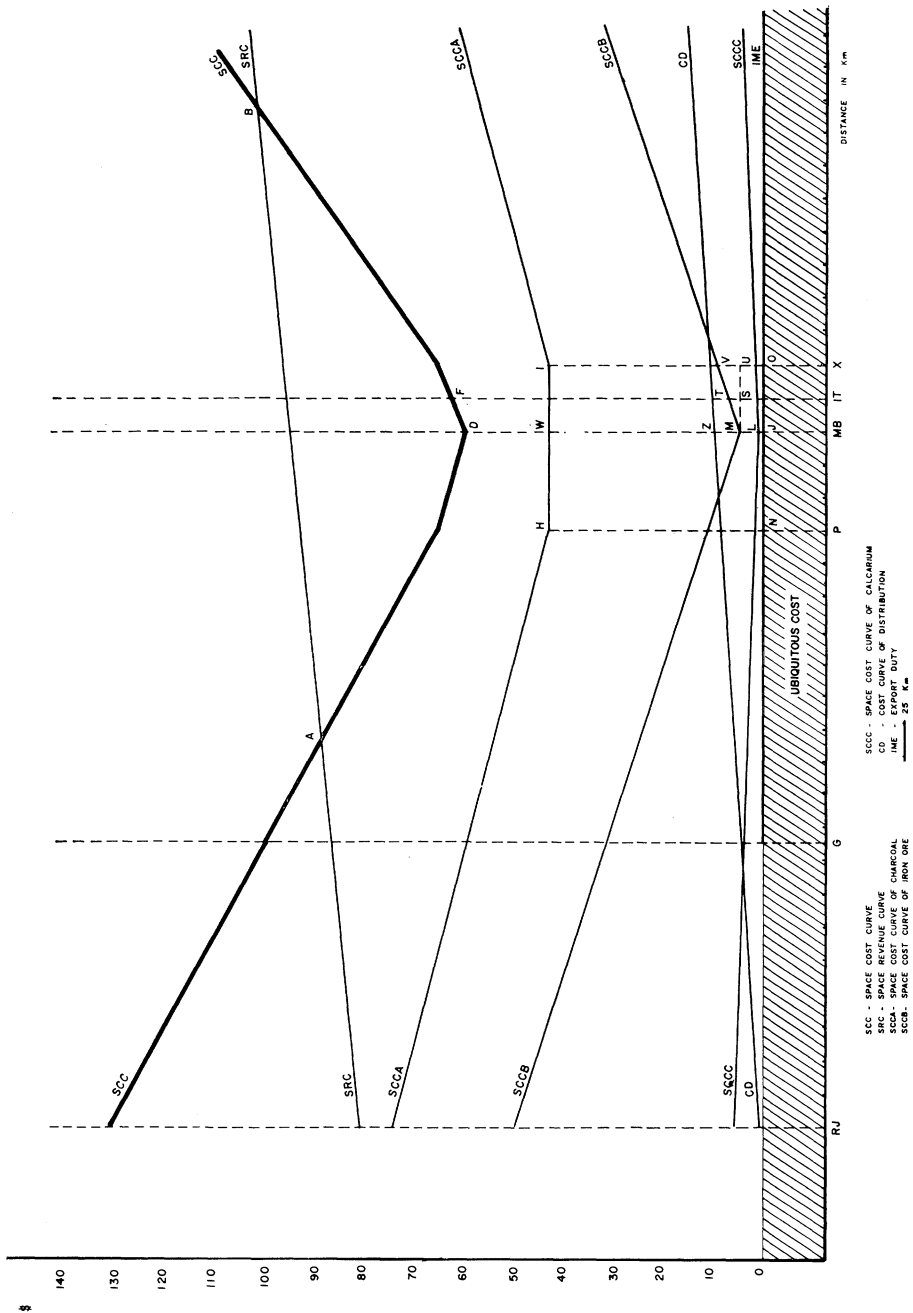
Fig. 1. Space cost curve for steel mill at Itabirito.

Itabirito. We could then include the distribution costs in our diagram using the equation:

$$CD = 0.94 \ [0\$021 \bullet d_1] + 0.06 \ [0\$021 \bullet d_2]$$

where 0\$021 is the railway tariff to transport a ton of steel per km; d_1 is the distance in km from a given site to Rio and d_2 is the distance in km of the same site to Itabirito, d_1 plus d_2 being equal to 523 km, the total distance between Rio and Itabirito.

The basic idea behind this formula is that (from any site) it is necessary to distribute 0.94 ton to Rio and 0.06 ton to Itabirito for each ton of steel produced. Then,

$$CD = 0.94 \ (0\$021 \bullet d_1) + 0.06 \ [0\$021 \\ (523-d_1)] \\ = 0\$650 + 0\$0185 \ d_1$$

If $d_1 = 0$, the firm is located in Rio and $CD = 0\$650$; if $d_1 = 523$, the firm is located in Itabirito and $CD = 10\$320$.

The cost curve of the export duty (IME) was computed by multiplying 0\$300 by 0.94 minus the part of each ton that would have to be exported if the firm is located at any site within the state of Minas Gerais. This curve appears in the diagram only on that part of the abscissa relative to that state.

To compute the space revenue curve (SRC), we used the same procedure as in the case of the distribution cost curve taking, as given, the F.O.B. price of a ton of steel equal to 80\$000 for that period. This last assumption comes from the fact that the plant was a marginal supplier in the Brazilian steel market which was supplied mainly by imports, as can be seen in the study of Calógeras [3].

Then, the space revenue curve becomes:

$$SRC = 0.94 \ (80\$000 + 0\$021 \bullet d_1) + 0.06 \ (80\$000 + d_2 \bullet 0\$021)$$

and $d_1 + d_2 = 523$ km. If $d_1 = 0$, the firm is located in Rio and the value of

$SRC = 80\$650$; if $d_1 = 523$, the firm is located in Itabirito and $SRC = 90\$320$.

When we compare the SRC and the SCC, we can see that unit profits would be greater if the steel mill had been located at Miguel Burnier (MB), only 25 km from Itabirito. This result shows that there was a good degree of rationality in locating the mill in the region of Itabirito. If we could add to our study statistical information about other relevant locational factors such as urban amenities, costs of energy, costs of transporting workers, etc., it might be possible that Itabirito could even be considered the best site for the location.

Finally, we might question the present competitive advantages of a propulsive firm which was located at the end of the nineteenth century basically oriented to the transportation system existing at that time. This topic could only be discussed if it were possible to study the changes which occurred in the relative importance of the many locational factors in the iron and steel industry in the last century. Although such a study is not available for the Brazilian economy, we can generalize and state that transportation is still the predominant locational factor, influencing the recent location of new plants belonging to this sector. Therefore, the steel mill of Itabirito still maintains its position among the leading firms in the market of steel in Brazil.

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